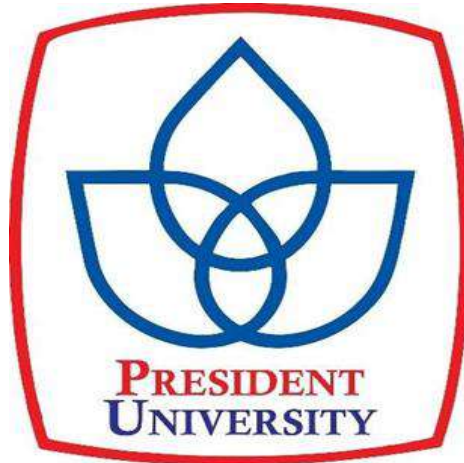




**COMPARISON OF MAXIMUM LIKELIHOOD
ESTIMATION AND METHOD OF MOMENTS FOR
ESTIMATING PARETO DISTRIBUTION
PARAMETERS ON MEDICAL MALPRACTICE
CLAIMS**

UNDERGRADUATE THESIS

**Submitted as one of the requirements to obtain
Sarjana Aktuaria (S.Aktr)**

By:

Erika Prischilia Simanjuntak

021202100018

**FACULTY OF BUSINESS
ACTUARIAL SCIENCE STUDY PROGRAM
CIKARANG**

August, 2024

PLAGIARISM REPORT

ORIGINALITY REPORT

14%

SIMILARITY INDEX

8%

INTERNET SOURCES

14%

PUBLICATIONS

5%

STUDENT PAPERS

PRIMARY SOURCES

1

Maria Dolores Ugarte, Ana F. Militino, Alan T. Arnholt. "Probability and Statistics with R", Chapman and Hall/CRC, 2019

Publication

1%

2

Vijay P. Singh. "Entropy-Based Parameter Estimation in Hydrology", Springer Science and Business Media LLC, 1998

Publication

1%

3

R Marsitin. "Analysis of Differential Calculus in Economics", Journal of Physics: Conference Series, 2019

Publication

1%

4

epdf.tips

Internet Source

1%

5

mryangteacher.weebly.com

Internet Source

1%

6

ojs.unm.ac.id

Internet Source

1%

7

atrium.lib.uoguelph.ca

Internet Source

1%

ARTIFICIAL INTELLIGENCE REPORT

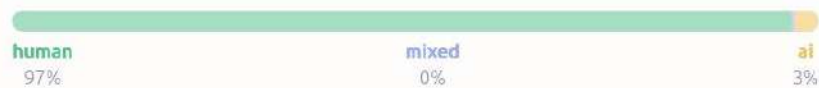
Document Classification



3% Probability AI generated ⓘ

highly confident ⓘ

Probability Breakdown



Our detector is highly confident that the text is written entirely by a **human**.

AI Scan

3%

There is a 3% chance this text was written entirely by AI.

Stats

287 words
14 sentences
0 sentences generated by AI

ABSTRACT

Medical Malpractice Claims present unique challenges for healthcare providers and insurance carriers because of their uncertain nature. Large financial losses arising from a high claim count are difficult to quantify. Therefore, an appropriate distribution model and estimation method are essential for effective risk management and planning. One of the significant distribution models is Pareto Distribution, having estimation techniques such as Maximum Likelihood Estimation (MLE) and Method of Moments (MoM). The objective of this study is to investigate the potential performance disparity between two major types of methods that is Maximum Likelihood Estimation and Method of Moments for estimating Pareto distribution parameters on medical malpractice claims data as applied specifically to the frequency-of-claims problem, focusing particularly on claim ages falling within age interval 36–65 years. The evaluation is done based on error metrics that is Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE), Mean Squared Error (MSE), and Root Mean Squared Error (RMSE). The analysis results show that MAE value for MoM is 0.02065, while for MLE is 0.01883. The MAPE calculation results show that the prediction value of MoM is 63%, while that of the MLE is 57%. In addition, the MSE value for MoM is 0.00060 and for the MLE is 0.00047. Last, the RMSE value for MoM is 0.02440, while for the MLE is 0.02163. Furthermore, the MAPE exceeding 50% indicates both methods are less effective for this particular case. However, based on the MAE, MSE, and RMSE results in this study, MLE and MoM show almost the same accuracy, so both methods can be considered equally good for parameter estimation. Nonetheless, in general, MLE is often considered a better method than MoM due to its more comprehensive approach in theory.

Keywords: *Medical Malpractice Claims, Pareto Distribution, Maximum Likelihood Estimation, Method of Moments*

ABSTRAK

Klaim malpraktik medis merupakan tantangan besar bagi tenaga medis dan perusahaan asuransi karena ketidakpastiannya yang tinggi. Banyaknya klaim dapat menimbulkan kerugian finansial yang signifikan dan sulit diprediksi. Untuk perencanaan risiko yang lebih efektif, diperlukan model distribusi dan metode estimasi yang tepat. Salah satu model distribusi yang relevan adalah Distribusi Pareto, dengan metode estimasi seperti Maximum Likelihood Estimation (MLE) dan Method of Moments (MoM). Penelitian ini bertujuan untuk membandingkan dua metode utama yaitu Maximum Likelihood Estimation dan Method of Moments, dalam menentukan parameter distribusi Pareto pada data klaim malpractice medis khususnya pada frekuensi klaim untuk rentang usia 36-65 tahun. Evaluasi dilakukan menggunakan metrik kesalahan yaitu Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE), Mean Squared Error (MSE), dan Root Mean Squared Error (RMSE). Hasil analisis menunjukkan bahwa MAE untuk MoM adalah 0.02065, sedangkan untuk MLE adalah 0.01883. MAPE menunjukkan 63% untuk MoM dan 57% untuk MLE. MSE untuk MoM adalah 0.00060, sementara untuk MLE adalah 0.00047. RMSE untuk MoM adalah 0.02440, sedangkan untuk MLE adalah 0.02163. Selain itu, MAPE yang melebihi 50% menunjukkan bahwa kedua metode kurang efektif untuk kasus ini. Namun, berdasarkan hasil MAE, MSE, dan RMSE dalam penelitian ini, MLE dan MoM menunjukkan akurasi yang hampir sama, sehingga kedua metode dapat dianggap sama-sama baik untuk estimasi parameter. Meskipun demikian, secara umum, MLE sering dianggap sebagai metode yang lebih baik dibandingkan MoM karena pendekatannya yang lebih komprehensif secara teori.

Keywords: *Klaim Malpraktik Medis, Distribusi Pareto, Maximum Likelihood Estimation, Method of Moments*

TABLE OF CONTENTS

PANEL OF EXAMINERS APPROVAL	i
STATEMENT OF ORIGINALITY	ii
SCIENTIFIC PUBLICATION APPROVAL FOR ACADEMIC INTEREST	iii
ADVISOR'S APPROVAL FOR PUBLICATION	iv
PLAGIARISM REPORT	v
ARTIFICIAL INTELLIGENCE REPORT	vi
ABSTRACT	vii
ABSTRAK	viii
ACKNOWLEDGEMENT	ix
TABLE OF CONTENTS	x
LIST OF TABLES	xiii
LIST OF FIGURES	xiv
CHAPTER I INTRODUCTION	1
1.1 Background	1
1.2 Problem Statement	3
1.3 Research Question	4
1.4 Research Objectives	4
1.5 Research Scope and Limitation	4
1.6 Thesis Organization	5
CHAPTER II LITERATURE REVIEW	6
2.1 Exponential and Logarithm Function	6
2.1.1 Exponential Function	6
2.1.2 Logarithm Functions	7
2.1.3 Natural Logarithm	7
2.2 Derivatives	8
2.2.1 Rules of Derivatives	9
2.2.2 Maxima and Minima	10
2.2.3 Partial Derivatives	11
2.3 Basic Probability Concept	13
2.3.1 Sample Space	13
2.3.2 Event	13

2.4 Random Variable.....	14
2.4.1 Discrete Random Variable.....	14
2.4.2 Continuous Random Variable.....	15
2.5 Expectation.....	15
2.6 Variance.....	16
2.7 Standard Deviation	16
2.8 Covariance	17
2.9 Moments.....	17
2.10 Conditional Distribution.....	18
2.11 Pareto Distribution	19
2.11.1 Pareto Type I Distribution	19
2.11.2 Pareto Type II Distribution.....	19
2.12 Parameter Estimation	20
2.13 Method of Moments	21
2.14 Maximum Likelihood Estimation	22
2.15 Performance Evaluation of The Method	23
2.15.1 Mean Absolute Error (MAE).....	23
2.15.2 Mean Absolute Percentage Error (MAPE)	23
2.15.3 Mean Squared Error (MSE).....	23
2.15.4 Root Mean Squared Error (RMSE)	23
2.16 Previous Studies	24
CHAPTER III METHODOLOGY	26
3.1 Research Design	26
3.2 Data Collection.....	26
3.3 Data Analysis Design	26
3.4 Research Flowchart	28
CHAPTER IV ANALYSIS AND RESULT.....	32
4.1 Estimating Pareto Distribution Parameter using Method of Moments	32
4.2 Estimating Pareto Distribution Parameter using Maximum Likelihood Estimation.....	33
4.3 Data Pre-processing.....	34
4.4 Data Simulation and Analysis	36
CHAPTER V CONCLUSION.....	39

5.1 Conclusion.....	39
5.2 Suggestion	40
REFERENCES.....	41

LIST OF TABLES

Table 4. 1 Overview of Medical Malpractice Dataset	35
Table 4. 2 Tabel of Frequency Distribution Based on the Age of Doctors.....	35
Table 4. 3 Table of Actual Probability and Estimation Result	36
Table 4. 4 Table of MAE and MAPE Result	37

LIST OF FIGURES

Figure 3.1 Flowchart of Method of Moments	28
Figure 3.2 Flowchart of Maximum Likelihood Estimation	30